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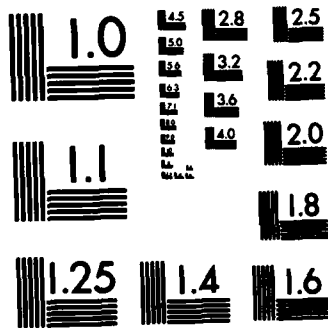
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Final Report

August 1982

AN ANALYSIS OF NAVAL PERSONNEL RESOURCE ALLOCATIONS TO LOGISTICS

Volume II — Methodology for Examining Effects of Personnel Shortfalls on Navy Logistics Personnel Readiness

By: RICHARD H. MONAHAN

Prepared for:

DAVID W. TAYLOR NAVAL SHIP
RESEARCH AND DEVELOPMENT CENTER
BETHESDA, MARYLAND 20084

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SRI Project 1665

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relative to the broad area of logistics support and also to selected subareas of logistics such as maintenance, own-unit support, and supply. Following an introductory chapter, Chapter II presents a summary of the methodology developed and the results of an illustrative example used to demonstrate the use of this methodology in examining personnel shortfall effects on Navy Logistics personnel readiness. In Chapter III, the basic data bases that were available for use in this analysis are described. The methodology that was developed to satisfy the objective of this analysis is then described in Chapter IV, including a summary description of the computer program UALLOC designed to optimize Navy-wide logistics personnel readiness for various levels of personnel shortfalls. Chapter V then presents an illustrative example of the use of this methodology in examining the effects of personnel shortfalls on Naval logistics personnel readiness. This chapter also includes a brief critique of the methodology and indicates additional steps that could be implemented to improve on the usefulness of this type of approach to personnel readiness evaluation.

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PREFACE

This report documents the analysis and findings of a research project conducted for the David W. Taylor Naval Ship Research and Development Center (DTNSRDC), Bethesda, Maryland. The sponsor and technical monitor was M.J. Zubkoff, Code 187, of DTNSRDC. The work was performed under Contract N00167-80-C-0068.

The research was performed in the Center for Defense Analysis (CDA) of the Research and Analysis Division (RAD) of SRI International. J. Naar is Director of CDA, and D.D. Elliott is Executive Director of RAD.

R.H. Monahan was project leader and principal investigator. He was assisted by W. Schubert.

SRI extends its appreciation to personnel at the Navy Manpower and Material Analysis Center, Pacific, Captain S.J. Watlington, Commanding Officer, for their assistance in the data base development phase of this research project.

I INTRODUCTION

The objective of the research described in this report was to develop and demonstrate the use of a methodology that would be useful in examining the effects of personnel shortfalls on Navy personnel readiness relative to the broad area of logistics support and also to selected subareas of logistics such as maintenance, own-unit support, and supply.

In previous research conducted for the David W. Taylor Naval Ship Research and Development Center, SRI International analyzed the allocation of Navy shore-based personnel resources^{*1} and Navy sea-based personnel resources (Volume I of this report) to logistics functions. These analyses indicated that considerable portions of Navy personnel resources, both ashore and afloat, are allocated to the various logistics functions. This implies that broad-based personnel shortfalls within the Naval manpower structure would significantly affect Naval readiness, not only from the standpoint of providing sufficient forces to conduct combat operations, but also from the standpoint of providing logistical support to these forces, without which they could not maintain and sustain an adequate level of operational capability. The research described in this volume supplements the previous research by providing an approach to evaluating the ramifications of personnel shortfalls on Naval logistics personnel readiness.

Chapter II presents a summary of the methodology developed and the results of an illustrative example used to demonstrate the use of this methodology in examining personnel shortfall effects

* References are listed at the end of this report

on Navy Logistics personnel readiness. In Chapter III, the basic data bases that were available for use in this analysis are described. The methodology that was developed to satisfy the objective of this analysis is then described in Chapter IV, including a summary description of the computer program UALLOC designed to optimize Navy-wide logistics personnel readiness for various levels of personnel shortfalls. Chapter V then presents an illustrative example of the use of this methodology in examining the effects of personnel shortfalls on Naval logistics personnel readiness. This chapter also includes a brief critique of the methodology and indicates additional steps that could be implemented to improve on the usefulness of this type of approach to personnel readiness evaluation.

II SUMMARY

A. Personnel Readiness

Personnel readiness is a factor that addresses the availability of sufficient, qualified personnel to perform the required objectives of a Naval activity to perform its assigned mission responsibilities. For this research effort, a Naval activity is defined to include specific Naval organization units (ships or aircraft squadrons) and the shore-based mission areas as specified for the SHORSTAMPS/SHOROC manpower planning program (aircraft maintenance, automatic data processing, communications, etc.). A measure of personnel readiness must consider not only the availability of the required numbers of officers, petty officers, other enlisted personnel, and civilians within an organizational unit or activity, but also the maintenance of a proper balance of these personnel with respect to mission essential skills, training, and Naval experience. The personnel authorizations contained in the ship and aircraft squadron manpower documents, and the SHORSTAMPS/SHOROC manpower planning program provide the standards for measuring personnel readiness strictly on a numerical basis. That is, if a unit or activity is staffed strictly in accordance with its authorization, then that unit or activity can be considered to possess a 100% rating for personnel readiness. Deviations from these authorizations, especially in the sense of shortfalls, will degrade personnel readiness, although the amount of degradation will be highly dependent upon the specific areas where the shortfalls occur. Thus, the procedure used to determine personnel readiness degradations from the standard must consider the full spectrum of the established personnel authorizations.

The approach used in this research effort is based on the assignment of utility values to the various personnel billets authorized to an activity. The personnel readiness standard for an activity is its authorized utility and is computed as the sum of the utilities of each authorized billet for that activity. In the event of deviations from an activity's authorized billet structure, personnel readiness is then defined as the ratio of achieved utility to authorized utility, where achieved utility is computed as the sum of the utilities of the assigned personnel to that activity. This definition of personnel readiness can be used for a single activity, a group of activities (such as all surface ships), or the entire Navy. It also can apply to specific functional segments of the Navy such as maintenance operations or supply operations.

B. Data Bases

The development of the methodology in support of this research effort was constrained by the availability of useful input data. The primary data sources for the data bases established under this research effort were the Ship Manpower Documents and the Aircraft Squadron Manpower Documents contained in OPNAV Instructions, the Standards Implementation Document System (SIDS) data base tapes, and an outside contractor report on the accrued utility of Navy enlisted personnel. Five basic data bases were generated from these data sources. Four of these basic data bases represent personnel authorizations to surface ships, subsurface ships, aircraft squadrons, and shore mission areas. These basic personnel data bases specify the numbers of officers, enlisted personnel, and civilians allocated to each activity within the above specified subgroupings, broken down in terms of officer designators/EP ratings/civilian occupational codes and pay grades, where civilian pay grades were identified separately for four civilian pay plans (General Schedule, Federal Wage System-Supervisory, Federal Wage System-Leader, and Federal Wage System-Non-supervisory). The fifth basic data base consists of

utility values associated with various EP ratings, assembled into seven distinct utility skill groups and varying by pay grade.

The basic data bases were then combined and transformed into five utility structured data bases, each representing one functional segment of the Navy (entire Navy, designated logistics, maintenance, own-unit support, and supply). These transformations first involved an expansion of the basic utility data base to include officers and civilians, as well as enlisted personnel. This step resulted in the establishment of 18 utility pay grades to represent the full spectrum of officer, enlisted, and civilian pay grades. This utility data base was then combined with the basic personnel data bases to generate the five utility structured data bases.

C. Methodology

The methodology developed for this research effort, which represents an initial approach toward evaluating the effects of personnel shortfalls on Navy logistics personnel readiness, is based on the application of a modified utility evaluation concept to the definition of personnel readiness as the ratio of achieved utility to authorized utility. Initially, personnel within a given utility skill group/pay grade combination are assigned a constant utility value, regardless of the activity to which assigned. These utility values are then modified to reflect the relative utility of a person in relation to the authorized strength of an activity for each skill group/pay grade combination. That is, the utility value associated with the x^{th} person in a particular skill group/pay grade combination assigned to a given activity depends on the number of personnel of that skill group/pay grade combination authorized to that activity and this utility value varies inversely (in a linear manner) with the value of x . Thus the utility loss associated with losing one person when an activity is at its authorized strength with respect to a skill group/pay grade combination is much less than the utility loss associated with losing one person when the activity is at, say, one-half its authorized strength for that skill

group/pay grade combination. Also, if one activity is assigned, say, twice as many personnel of a particular skill group/pay grade combination than is another activity, then the utility loss associated with the loss of one person from the first activity will be much less than the utility loss associated with the loss of one person from the second activity.

A computer program, designated by the acronym UALLOC, was developed to implement this approach. This program is designed to optimize Navy-wide personnel readiness for various levels of shortfalls among the six different pay categories (officers, enlisted personnel, and the four civilian pay plans) under minimum manning level restrictions specified for the four different force groups (surface ships, subsurface ships, aircraft squadrons, shore mission areas). The program was designed to operate with any one of the five utility structured personnel data bases established for this analysis. Thus, the program can provide optimal allocations for the entire Navy, as well as for the restricted segments representing designated logistics, maintenance, own-unit support, and supply. The program utilizes as input one of the utility structured data bases and a force structure data base, which specifies the number of activities of each type within the Navy force structure subjected to analysis. In addition, specific case inputs are also prescribed which specify the minimum required manning levels for the four force groups and the percentages of shortfall for each pay scale (officers, enlisted personnel, and the four civilian pay plans). Having read in all the inputs, the program then performs its major function of determining the activity allocations, under the shortfall and minimum manning level conditions prescribed, that optimize achieved Navy-wide utility, or equivalently, Navy-wide personnel readiness. This is accomplished through repeated use of the subroutine OPUTIL. This subroutine operates on a specific pay scale/skill group/pay grade combination and minimizes its Navy-wide utility degradation for the specified personnel shortfall, under the restricted minimum manning level requirements. The subroutine uses an iterated Lagrange Multiplier procedure to accomplish the utility

minimizations. When the optimal allocations have been completed, the program then computes the summary outputs. These include the resulting personnel allocations and achieved utilities for each activity, in addition to the ratios of assigned personnel to authorized personnel (personnel availability) and achieved utility to authorized utility (personnel readiness) for each activity. The outputs also include the same as the above for the four force groups (surface ships, subsurface ships, aircraft squadrons and shore mission areas), in addition to the entire Navy.

D. Sample Application

The sample application of the use of the methodology developed is based on a set of 60 computer runs of the Utility Optimization Computer Program (UALLOC). For each of the five utility structured data bases, representing respectively the entire Navy and the four logistics functional areas (designated logistics, maintenance, own-unit support, and supply), four levels of shortfalls (5%, 10%, 15%, 20%) were assumed under three different manning level restriction assumptions (no minimum manning level requirements; 80% minimum manning level requirements for afloat forces with 70% minimum manning level requirements for ashore forces; and 90% minimum manning level requirements for afloat forces with 70% minimum manning level requirements for ashore forces).

The results obtained indicated that there were relatively insignificant differences among the personnel availability and personnel readiness values obtained for the five different base populations (entire Navy, designated logistics, etc.). The personnel readiness values obtained for the four force groups (surface ships, subsurface ships, aircraft squadrons, and shore mission areas) generally adhere to those that could be theoretically predicted. This is shown in the table below where the results are those obtained under no minimum manning level requirements.

Shortfall Percentage	Computed Personnel Readiness		Theoretical Prediction
	Minimum	Maximum	
5	.996	1.000	.997
10	.986	1.000	.986
15	.971	.995	.976
20	.948	.978	.958

The theoretical predictions are based on the shortfalls being assessed against a single utility skill group/pay grade combination with an authorized strength of 100 personnel. For the most part, the personnel readiness values obtained under no minimum manning level requirements do not significantly differ across the four force groups for a given shortfall level. This reflects the intent of the modified utility approach where shortfalls in individual categories are applied to activities where the least degradation in utility would be achieved so that personnel readiness tends to remain on even levels, especially when applied to large subgroups of activities such as the force groups assumed in this research effort.

The personnel availability values obtained under no manning level restrictions show that the Subsurface Ship Force Group, with the smallest average activity personnel complements among the four force groups, exhibits the highest officer and enlisted availabilities, while the Shore Mission Area Force Group, with the highest average activity personnel complements, exhibits the lowest officer and enlisted availabilities. This is as would be expected since the modified utility approach applies the shortfalls proportionately more heavily on the larger activities than the smaller ones. The ranges in officer and enlisted availabilities obtained are given in the following table:

Shortfall Percentage	Officer Availability		Enlisted Availability	
	Minimum	Maximum	Maximum	Minimum
5	.931	1.000	.925	1.000
10	.868	1.000	.869	1.000
15	.811	1.000	.818	.987
20	.761	1.000	.770	.952

The civilian availabilities obtained are the direct unity complement of the shortfalls, as the Shore Mission Area Force Group is the only force group of the subgroups that contain civilian personnel. When the manning level restrictions are imposed, the general trend is a shifting of shortfalls from the afloat force groups with the higher minimum manning level requirements (80% or 90%) to the ashore force group with the lower minimum manning level requirement (70%). For the 80% requirement imposed on the afloat forces, some shifting of the shortfalls from the Surface Ship Force Group to the Subsurface Ship and Aircraft Squadron Force Groups, in addition to the ashore force group, also takes place. However, at the 90% minimum manning level requirement, the shifting is totally from the afloat force groups to the ashore force group.

E. Critique of Proposed Approach

The modified utility evaluation concept developed under this research effort represents an initial approach toward evaluating the effects of personnel shortfalls on Navy personnel readiness relative to logistics support functions. This type of approach has two significant features useful for evaluating personnel readiness.

The first useful feature is the relating of personnel readiness to the utility associated with assigned personnel to an activity. This provides a logical basis for assessing personnel readiness in terms of the relative worth of specific personnel billets to the performance of an activity's mission requirements. Although each billet authorized to an activity is necessary to the full performance of the activity's prescribed missions, these billets have differing criticalities with regards to mission performance and the loss of a person in a non-mission essential skill area would have much less of an effect on the activity's mission performance than the loss of a person in a mission essential skill area, especially under combat conditions.

The second useful feature of the proposed type of approach is in the capability of optimizing personnel readiness over a group of activities in the presence of personnel shortfalls within specific skill group/pay grade combinations. That is, this approach provides a rational method for distributing personnel shortfalls among a group of activities so as to minimize the degradation of the overall personnel readiness of that group of activities.

One desirable feature that is not included in the proposed type of approach is the capability for personnel substitution either among pay grades within a specific skill category or among skill categories for a specific pay grade.

The actual implementation of the proposed type of approach consists of two components: data base consolidation and optimization computer program design. The data base consolidation embodies the transformation of the basic personnel data bases to utility structured data bases. This data base consolidation resulted in a considerable reduction in the number of data base factors. The principal advantage of this consolidation is a four-fold reduction in the maximum number of allocation optimizations required for a given computer run, which translates to a substantial reduction in computer running time. A disadvantage of the data base consolidation is the loss of identity of actual billets, where officers, enlisted personnel, and civilians are identified as members of utility skill groups and not by officer designators, EP ratings, or civilian occupational code groups. This could be offset somewhat by increasing the number of utility skill groups so that each skill group would contain fewer officer designators, EP ratings, and civilian occupational codes and the skill group definitions themselves could be revised to be more related to specific Naval functions. Another area where improvement is required is in the componentization of shore based activities where the nature of these activities should be more compatible with that of the afloat activities (ships and aircraft squadrons) than are the Shore Mission Areas. One such option would be to use the actual shore

activities, such as Naval bases, supply centers, air stations, and so on. This revision, as well as the skill group redefinition, would obviously increase the number of data base factors and thus increase computer running time requirements. On the other hand, it should also add credibility to the results obtained through the use of the approach.

The Utility Optimization Computer Program (UALLOC) represents a convenient and efficient tool for evaluating personnel readiness in the presence of personnel shortfalls. The principle drawback of the program is that it generates abnormally high values for personnel readiness in relationship to the personnel availabilities obtained, as can be seen through perusal of the tables presented in the preceding section. The high readiness values generated by the program imply that the linearly variant utility assumption, used to establish the relative utility values of personnel authorized to an activity within a specific utility skill group/pay grade combination, places too little utility value at the end of the personnel scale. One possible option to correct this problem would be to establish a critical manning level, say 80%, where relative utility would be constant up to this critical level and then decrease linearly up to the 100% level. Another option would be to use a concave function instead of a linear function to represent relative utility. Another drawback of the program is the assumption that shortfalls are uniform over utility skill groups and pay grades. That is, if a shortfall of, say, 80% is assumed, then each utility skill group/pay grade combination is assumed to have an 80% shortfall. One possible remedy to this problem would be to allow non-uniform shortfall distributions over the utility skill groups and pay grades. This would allow evaluation of personnel readiness in such cases where there is a higher shortfall among, say, personnel in the highly critical skill areas or with higher pay grades than among those in less critical skill areas or with lower pay grades. Implementation of the above two proposed improvements would result in a more useful and credible computer program as a tool for evaluating personnel readiness in the presence of personnel shortfalls.

III BASIC PERSONNEL DATA BASES

The development of the methodology, in support of this analysis, was constrained by the availability of useful input data. This chapter describes the available data bases that were obtained to satisfy the objective of this analysis. The basic personnel data bases, described in Section B, were those used in the previous analyses of Navy personnel resource allocations to logistics support functions as documented in Volume I of this report and in the previous report on shore-based personnel resource allocations.¹ Personnel readiness, as defined for this analysis, was based on the assignment of relative utility values to the various authorized billets within the Navy manpower structure. The basic data used for these utility assignments are described in Section C. Section A of this chapter identifies the data sources that were used to establish the data bases discussed in Sections B and C of this chapter.

A. Data Sources

The data contained in the Basic Personnel Data Bases used in this analysis were obtained from several sources. The primary sources were the Ship Manpower Documents and the Aircraft Squadron Manpower Documents, contained in the 5320 Series of the OPNAV Instructions,² and the Standards Implementation Document System (SIDS) data base tapes.³ The documents and the data base tapes were used to determine the numbers of officers, enlisted personnel (EP), and civilians allocated to each ship class, aircraft squadron type, and shore mission area in the Navy. These data were broken down in terms of officer designators and pay grades,

EP ratings and pay grades, and civilian occupational code groupings and pay grades for four different civilian pay plans: General Schedule (GS), Federal Wage System-Supervisory (WS), Federal Wage System-Leader (WL) and Federal Wage System-Nonsupervisory (WG)(other civilian pay plans were equivalenced to one of these four pay plans). The manner by which the personnel data bases were derived from the data sources is discussed in the next section of this chapter.

The utility data used in this analysis are based on utility curves derived from tables contained in a Decisions and Designs, Inc. report on accrued utility of Navy enlisted personnel.⁴ The basic utility data used are discussed in Section C of this chapter.

B. Personnel Data Bases

Four distinct basic personnel data bases were generated for the purposes of this analysis: Surface Ship Personnel Data Base, Subsurface Ship Personnel Data Base, Aircraft Squadron Personnel Data Base, and Shore Mission Area Personnel Data Base. This categorization of personnel allocations is compatible with the companion analyses documented in Volume I of this report and Reference 1. The first three data bases are identical with the sea-based personnel data bases used in the analysis documented in Volume I of this report. They are briefly discussed in the following subsection. The Shore Mission Area Personnel Data Base was generated specifically for this analysis. The details of this data base generation are described in Subsection 2 of this section.

1. Basic Sea-Based Personnel Data Bases

Three basic sea-based personnel data bases were established for this analysis. These data bases represent personnel that are allocated to active ships and aircraft squadrons within the Navy, regardless of whether or not a ship is in port or an aircraft squadron is actually land-based. For the purposes of this analysis, it was convenient to separate the

sea-based Naval forces into three groups: surface ships, subsurface ships, and aircraft squadrons. Thus, a separate data base was established for each of these groupings.

The primary data sources for these data bases were the Ship Manpower Documents and the Aircraft Squadron Manpower Documents, contained in the OPNAV Instructions. These documents were used to determine the numbers of officers and enlisted personnel allocated to each ship class and each aircraft squadron type in the Navy, broken down in terms of officer designators/EP ratings and pay grades (civilians are not allocated to the sea-based forces). In a few cases where manpower documents were unavailable, manpower allocations were synthesized from analogous manpower documents by application of ratios of known officer and EP complements. Since the manpower document data had to be manually converted to computerized data bases, several reduction assumptions were imposed which reduced data reduction time, but would not induce any significant errors in light of the level of aggregation required for this analysis. These data reduction assumptions included: the selection of a typical ship within a ship class as representative of that ship class; assuming small classes of ships to be members of a larger analogous class; and the selection of a typical aircraft squadron type to be representative of a variety of numbered squadrons of a similar nature. A more detailed description of these data reduction measures is contained in Volume I of this report, where the same sea-based data bases were utilized.

Figures III-1 to III-3 present excerpts respectively of the Surface Ship Personnel Data Base (MDFILE), the Subsurface Ship Personnel Data Base (SSFILE), and the Aircraft Squadron Personnel Data Base (SQFILE). In respective order, these figures portray the officer and enlisted manpower allocations for the Surface Ship Class CGN-25(USS Bainbridge), the Subsurface Ship Class SSN-594(USS Permit), and the Aircraft Squadron Type VX-4(Air Test and Evaluation Squadron Four). The first record shown on each figure specifies the ship class or aircraft squadron type (Columns 1-9); the force class type (Column 10) where S = surface ship, U =

Figure III-1 SAMPLE SECTION-SURFACE SHIP PERSONNEL DATA BASE (MDFILE)

SSN	594U	317	0												
1120	0	0	0	0	0	1	2	3	4	0	0	0	0	0	10
1170	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
3100	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
0000	0	0	0	0	0	1	2	3	5	1	0	0	0	0	12
EM		0	1	0	4	2	2	0	0	0	0	9			
ET		0	0	2	3	0	0	0	0	0	0	5			
ETN		0	0	0	0	2	2	1	0	0	0	5			
ETR		0	0	0	0	3	2	0	0	0	0	5			
FIG		0	0	1	1	1	1	0	0	0	0	4			
HM		0	0	1	0	0	0	0	0	0	0	1			
IC		0	0	1	2	2	2	1	0	0	0	8			
MM		0	1	2	8	10	7	1	0	0	0	29			
MS		0	0	0	1	2	2	2	0	0	0	7			
PD		1	0	0	0	0	0	0	0	0	0	1			
QM		0	0	1	1	0	2	0	0	0	0	4			
RM		0	0	1	1	1	1	0	0	0	0	4			
SK		0	0	0	1	0	0	1	0	0	0	2			
SN		0	0	0	0	0	0	0	9	0	0	9			
STS		0	1	0	3	2	3	3	0	0	0	12			
TM		0	0	1	1	1	2	1	0	0	0	6			
YN		0	0	1	0	0	1	1	0	0	0	3			
EEEE		1	3	11	26	26	27	11	9	0	0	114			

**Figure III-2 SAMPLE SECTION - SUBSURFACE SHIP
PERSONNEL DATA BASE (SSFILE)**

VX	4A1029	0													
1000	0	0	0	0	0	0	0	1	1	0	0	0	0	0	2
1301	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2
1311	0	0	0	0	0	1	7	11	0	0	0	0	0	0	19
1321	0	0	0	0	0	0	5	8	0	0	0	0	0	0	13
1520	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
1630	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
2102	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
6330	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
6360	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
7380	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
0000	0	0	0	0	1	2	13	24	1	0	0	0	0	1	42
AD		0	1	2	5	8	8	9	0	0	0	0	0	33	
AE		0	2	1	3	6	9	6	0	0	0	0	0	27	
AF		1	0	0	0	0	0	0	0	0	0	0	0	1	
AK		0	0	0	1	3	2	1	0	0	0	0	0	7	
AM		0	1	0	0	0	0	0	0	0	0	0	0	1	
AME		0	0	0	3	2	4	4	0	0	0	0	0	13	
AMH		0	0	0	1	4	4	4	0	0	0	0	0	13	
AMS		0	0	2	4	7	10	10	0	0	0	0	0	33	
AN		0	0	0	0	0	0	0	48	0	0	0	0	48	
AO		0	0	1	3	3	5	4	0	0	0	0	0	16	
APD		1	0	0	1	5	0	0	0	0	0	0	0	7	
AQ		0	1	2	3	6	9	5	0	0	0	0	0	26	
ASE		0	0	0	0	0	0	2	0	0	0	0	0	2	
ASM		0	0	0	0	1	0	1	0	0	0	0	0	2	
AT		0	0	1	2	4	8	5	0	0	0	0	0	20	
AZ		0	0	0	2	2	2	2	0	0	0	0	0	8	
DK		0	0	0	0	1	0	0	0	0	0	0	0	1	
DM		0	0	0	0	0	1	0	0	0	0	0	0	1	
HM		0	0	0	1	0	0	0	0	0	0	0	0	1	
HN		0	0	0	0	0	0	0	2	0	0	0	0	2	
LI		0	0	0	0	0	1	0	0	0	0	0	0	1	
MS		0	0	0	0	1	1	2	0	0	0	0	0	4	
OS		0	0	1	0	0	0	0	0	0	0	0	0	1	
PH		0	0	0	0	1	0	0	0	0	0	0	0	1	
PN		0	0	0	1	1	2	2	0	0	0	0	0	6	
PO		0	0	0	2	5	1	0	0	0	0	0	0	8	
PR		0	0	0	1	1	2	2	0	0	0	0	0	6	
SN		0	0	0	0	0	0	0	2	0	0	0	0	2	
YN		0	0	1	2	1	3	6	0	0	0	0	0	13	
EEEE		2	5	11	35	62	72	65	52	0	0	0	0	304	

Figure III-3 SAMPLE SECTION-AIRCRAFT SQUADRON PERSONNEL DATA BASE (SQFILE)

subsurface ship, and A = aircraft squadron; the number of applicable officer designator entries (Columns 11-12); the number of applicable EP ratings (Columns 13-14); and the number of applicable civilian codes (Columns 15-16), which are always zero for sea-based forces. The next set of records each specify the officer designator, the numbers of officers per pay grade for that officer designator for Pay Grades O-10 down to O-1 and then W-4 down to W-1, and finally, the total number of officers for that officer designator. The officer designator set is terminated with an officer designator entry '0000', followed by the column total for each pay grade and finally the total number of officers. The next set of records applies in a similar manner to EP ratings, where the pay grades range from E-9 down to E-4, Designated Striker, and then E-3 down to E-1. This set is terminated with an EP rating entry 'EEEE', which contains the column totals.

2. Basic Shore Mission Area Personnel Data Base

The Basic Shore Mission Area Personnel Data Base established for this analysis represents personnel that are allocated to various activities within the Navy shore establishment. For purposes of this analysis it was convenient to group personnel in terms of their allocations to one of the mission areas established under the Shore Requirements, Standards, and Manpower Planning System/Shore Requirements Operational Capabilities (SHORSTAMPS/SHOROC) Program as defined in the SHOROC Dictionary.⁵ A total of 25 such mission areas are identified in this document. In addition, three additional categories are used in the SIDS data base, representing the Department of the Navy and Command Headquarters and Staff, students, and uncoded personnel (personnel billets that are not, as yet, allocated to any specific mission area). Table III-1 identifies these groupings together with the code used in the data base structure. For this analysis, these mission area groupings are used in an analogous manner as the ship classes and aircraft squadron types included in the sea-based personnel data bases.

Table III-1

SHOROC MISSION AREAS

Code	Mission Area
UN	Uncoded Personnel
HQ	Headquarters and Staff Personnel
ST	Students
ACM	Aircraft Maintenance
ADP	Automatic Data Processing
COM	Communications
CON	Construction of Shore Facilities
CPY	Cryptology
DEN	Dental
ELX	Electronics Material Support
ENV	Environmental Support
FAC	Facilities Support
FIR	Firefighting
FIN	Financial Services
FSS	Flight Support Services
ICS	Internal and Inter-Command Support
INT	Intelligence
MED	Medical
PER	Personnel Support
PSO	Port Service Operations
RCT	Recruiting
R&D	Research, Development, Test and Evaluation
SEC	Security
SFP	Shore Facilities Planning
SHP	Ship Repair
SUP	Supply
TRA	Training
WEP	Weapons

The data sources for this data base were the two SIDS data base tapes.³ These tapes contain slightly over 300,000 data records, where a record identifies a Naval activity, an officer or enlisted component within an activity, or an officer, enlisted, or civilian position (set of positions) within an activity. Each data base record is 163 characters in length and contains a variety of coded information relative to that activity, component, or position. In this analysis, the activity and component records were not required. For the position records, only selected data were required from a record. These were the mission area code; designator and pay grade for officers; rating and pay grade for enlisted personnel; pay plan, occupational code, and pay grade for civilians; and the number of current billets represented by the position record.

The selected data entries in a position record, when decoded, were for the most part directly applicable to the requirements of the shore-based data base used in this analysis. The one major exception occurs in the area of civilian pay plans. In the SIDS record descriptions, there are a total of 31 different civilian pay plans. For this analysis, it was convenient to consider the four prevalent pay plans and equivalence the remainder to these pay plans as much as possible. The pay plans used are the General Schedule (GS), Federal Wage System-Supervisory (WS), Federal Wage System-Leader (WL) and Federal Wage System-Nonsupervisory (WG). The other pay plans such as Canal Zone GS Type Positions (CZ), Maritime (WM), Foreign Defense Schedule (FD), and so on were equivalenced, for the most part, to these four pay plans as indicated in Table III-2. Except for the few exceptions noted in the table, pay grades for these pay plans were assumed the same as their equivalenced pay plan. Since pay grades were used to represent skill levels, and not for monetary value, these equivalencing relationships were assumed sufficiently representative for the purpose of this analysis.

Table III-2
CIVILIAN PAY PLAN EQUIVALENCIES

Primary Pay Plan			
General Schedule (GS)	Federal Wage System Supervisory (WS)	Federal Wage System Nonsupervisory (WG)	Federal Wage System Leader (WL)
AD - Administratively Determined Rates, Not Elsewhere Specified	MS - Canal Zone Manual, Supervisory	MO - Canal Zone Manual, Nonsupervisory	None
AG - Foreign National, Similar to GS Positions	NU - Foreign National, Similar to Ungraded Wage Service Positions (Grades 16-20)*	NU - Foreign National, Similar to Ungraded Wage Service Positions (Grades 1-15)	
CZ - Canal Zone GS Type Positions	WD - Nonsupervisory Wage Grade Production Facilitating Positions†	WB - All Wage Positions Not Paid Under Coordinated Federal Wage System Pay Schedule or Not Otherwise Designated	
EC - Experts and Consultants	WN - Supervisory Wage Grade Production Facilitating Positions**	WI - Printing and Lithographic Pay Schedules (WDC)††	
EX - Executive Pay	WY - Inspection Service, Supervisory	WM - Maritime Pay Schedules	
FD - Foreign Defense Schedule		WP - Printing and Lithographic Pay Schedules (Not WDC)††	
GW - Employment Under Schedule A213.3102 Classified and Paid at GS Rate		WT - Federal Wage System-Training	
NM - Canal Zone Nonmanual		WN - Employment Under Schedule A213.3102 Classified and Paid at a Regularly Established Rate Under a Wage System	
ST - Scientific and Professional		WX - Inspection Service, Nonsupervisory	
SZ - Canal Zone Special Category Type Positions		WZ - Canal Zone Wage System Type Positions	
ZZ - Employees Serving Without Compensation		YW - Summer Aid Employment	
		YW - Student Aid Employment	

* For NU pay grades 16-20, pay grade equivalencing formula WS = NU - 10 (Derived from Ref. 10)

† For all WD pay grades, pay grade equivalencing formula WS = WD + 2 (Derived from Ref. 10)

** For all WN pay grades, pay grade equivalencing formula WS = WN + 6 (Derived from Ref. 10)

†† For WI and WP pay grades 1-19, pay grade equivalencing formulas WG = INT (WI/2) + 3 and WC = INT (WP/2) + 3 (Derived from Refs. 11 and 12). Higher pay grades were omitted for lack of equivalencing information - 127 billets).

Equivalenced Pay Plans

In order to accumulate the personnel allocation data in a format compatible with the sea-based personnel data bases, a computer program, designated by the acronym SHRFIL, was designed to accomplish this purpose. This program is basically a bookkeeping program that reads selected portions of a data record, determines if that record is a position record, and, if so, translates the coded entries to be data-base compatible, and then accumulates and stores the number of billets into the appropriate data base file location. This file is actually a four-dimensional array with the first dimension the mission area; the second dimension being the pay plan such as officer, enlisted, general schedule, and so on; the third dimension being the designator, rating, or occupational code group respectively for officers, enlisted personnel, and civilians; and the fourth dimension being the pay grade, including an extra position for row totals. The value of an element in the array represents the total number of billets allocated to the shore-based Navy matching the four dimensional identifiers for that array element. If, in reading a data record, the program encounters an inconsistency in one or more of the selected data elements, it prints out, on a separate file, the data elements that were read for subsequent error analysis. The outputs of the program then are the Shore Mission Area Personnel Data Base (SHFILE) and an error listing of data records (SHFERR).

Several runs of SHRFIL were required to generate the shore-based data base. The first several runs, through analysis of the SHFERR output, identified a few cases where SHRFIL could be expanded to accommodate a number of the data base reading errors. The final run resulted in the generation of the Shore Mission Area Personnel Data Base. This run still identified a number of data record inconsistencies. The majority of these were enlisted personnel without specified pay grades, mainly musicians and enlisted students, primarily recruits. Although a fairly large number of billets were included in these two categories, their

exclusion from the data base was not considered significant for the purposes of this analysis as musician ratings would be given low priority in times of personnel shortfalls and the recruits would eventually be spread out among the enlisted ratings in the same proportions as those already included in the data base.

Figure III-4 presents an excerpt of the Shore Mission Area Personnel Data Base. This figure portrays the officer, enlisted, and civilian manpower allocations to the Environmental Support Mission Area (ENV). The first record shown on the figure specifies the mission area (Columns 1-4); the number of applicable officer designator entries (Columns 5-6); the number of applicable EP ratings (Columns 7-9); and the number of applicable civilian occupational code groups, broken down in terms of the GS pay plan (Columns 10-11), the WS pay plan (Columns 12-13), the WG pay plan (Columns 14-15), and the WL pay plan (Columns 16-17). Note that the WL entry for the sample excerpt is zero, indicating that there are no personnel under the Federal Wage System-Leader Pay Plan allocated to the Environmental Support Mission Area. The next set of records each specify the aggregated officer designator, the number of officers per pay grade for that designator for Pay Grades O-11 down to O-1, and then W-4 down to W-1, including a Commodore Pay Grade between Pay Grades O-7 and O-6, and finally the total number of officers for the aggregated officer designator. The aggregated officer designators, as defined in NPRDC Report SR80-18⁶, were assumed sufficient for the purposes of this analysis. The level of aggregation is identified by the inclusion of Xs in the officer designator entry. For example, all Submarine Warfare Officers with a designator in the 1120 series would be assigned the aggregated officer designator 112X. A complete list of the aggregated officer designators used in this analysis is presented in Table III-3. The officer designator set is terminated with an officer designator entry '0000', followed by the column totals for each pay grade and finally the total number of officers allocated to the mission area. The next set of records applies in a similar manner to EP ratings, where the EP

Figure III-4 SAMPLE SECTION-SHORE MISSION AREA PERSONNEL DATA BASE (SHFILE)

Table III-3

AGGREGATED OFFICER DESIGNATORS

Designator		Designator	
100X	Command Staff Officer	165X	Special Duty Officer (SDO)
105X	Command Staff Officer		--Public Affairs
110X	Other Line Officer	167X	Special Duty Officer (SDO)
111X	Surface Warfare Officer		--Merchant Marine, Engr.
112X	Submarine Warfare Officer	168X	Special Duty Officer (SDO)
113X	Special Warfare Officer		--General Administration
114X	Special Operations Officer	169X	Special Duty Officer (SDO)
116X	Surface Warfare Officer		--Merchant Marine, Comm.
117X	Submarine Warfare Officer	180X	Special Duty Officer (SDO)
118X	Special Warfare Officer		--Geophysics
119X	Special Operations Officer	191X	Medical Corps Officer
130X	Aviation Officer (Pilot)	192X	Dental Corps Officer
131X	Aviation Officer (Pilot)	193X	Medical Service Corps Officer
132X	Aviation Flight Officer	194X	Chaplain Corps
137X	Aviation Flight Officer	195X	Judge Advocate General's
139X	Aviation Officer (Pilot)		Corps Officer
140X	Engineering Duty Officer	196X	Medical Corps Officer
141X	Engineering Duty Officer	197X	Medical Corps Officer
144X	Engineering Duty Officer	210X	Medical Corps Officer
146X	Engineering Duty Officer	220X	Dental Corps Officer
150X	(Unknown)	230X	Medical Service Corps Officer
151X	Aviation Engineering	250X	Judge Advocate General's
	Duty Officer		Corps Officer
152X	Aviation Maintenance	290X	Nurse Corps Officer
	Duty Officer	310X	Supply Corps Officer
161X	Special Duty Officer (SDO)	410X	Chaplain Corps Officer
	--Crypto	510X	Civil Engineer Corps Officer
163X	Special Duty Officer (SDO)	6XXX	Line-Limited Duty Officer
	--Intelligence/Photo	7XXX	Warrant Officer
164X	Special Duty Officer (SDO)	8XXX	Warrant Officer
	--Intelligence /Photo		

ratings used in this analysis is presented in Table III-4 and were obtained, for the most part, from NPRDC Report SR80-7.⁷ This set is terminated with an EP rating entry 'EEEE', which contains the column totals. The next set of records applies to General Schedule civilian employees (including equivalenced pay plans), where the GS levels range from GS-18 down to GS-0. The occupational code groupings are aggregated by one hundred series increments and have been abbreviated by deleting the two trailing zeros. For example, the occupation code group 15 appearing in the file represents the 1500 series of white-collar occupational codes (Mathematics and Statistics). A complete list of the white-collar occupational code groups used in this analysis is presented in Table III-5 and are as defined in US Office of Personnel Management Report SM-56-14.⁸ This set is terminated with an occupational code group entry 'GSGS', which also contains the column totals. The next three sets of records apply to Federal Wage System employees (including equivalenced pay plans) in the order of Supervisory (WS), Nonsupervisory (WG), and Leader (WL). The WS pay grades range from WS-19 to WS-1, while the WG and WL pay grades range from WG-15 to WG-1 and WL-15 to WL-1. The occupational code groups are aggregated by one thousand series increments and have been abbreviated by deleting the trailing three zeros. For example, the occupational code group 67 in the file represents the 67000 series of blue-collar occupational codes (Manufacture and Repair Shop Operation). A complete list of the blue-collar occupational code groups used in this analysis is presented in Table III-6 and were obtained from US Office of Personnel Management Report SM59-12.⁹ These three sets of records are terminated with occupational code group entries 'WSWS', 'WGWG', and 'WLWL', respectively, where these records contain the column totals for the respective set of records. Note in the sample excerpt of Figure III-4, there are no WL data records as previously mentioned.

Table III-4

ENLISTED PERSONNEL RATINGS

Rating	Description	Rating	Description
AF	Aviation Boatswain's Mate	BM	Boatswain's Mate
ABE	Aviation Boatswain's Mate (Launching & Recovery Eqpm.)	BR	Boilermaker
ABF	Aviation Boatswain's Mate (Fuels)	BT	Boiler Technician
ABH	Aviation Boatswain's Mate (Aircraft Handling)	BU	Builder
AC	Air Controlman	CE	Construction Electrician
AD	Aviation Machinist's Mate	CM	Construction Mechanic
ADJ	Aviation Machinist's Mate (Jet Engine Mechanic)	CT	Communications Technician
ADR	Aviation Machinist's Mate (Reciprocating Mechanic)	CTA	Communications Technician (Administration Branch)
AE	Aviation Electrician's Mate	CTI	Communications Technician (Interpretive Branch)
AF	Aircraft Maintenance Man (E-9 only)	CTM	Communications Technician (Maintenance Branch)
AG	Aerographer's Mate	CTO	Communications Technician (Communications Branch)
AK	Aviation Storekeeper	CTR	Communications Technician (Collection Branch)
AM	Aviation Structural Mechanic	CTT	Communications Technician (Technical Branch)
AME	Aviation Structural Mechanic (Safety Equipment)	CU	Constructionman (E-9 only)
AMH	Aviation Structural Mechanic (Hydraulics)	DK	Disbursing Clerk
AMS	Aviation Structural Mechanic (Structures)	DM	Illustrator Draftsman
AN	Airman	DN	Dentalman
AO	Aviation Ordnanceman	DP	Data Processing Technician
APO	Aviation Petty Officer	DS	Data Systems Technician
AQ	Aviation Fire Control Technician	DT	Dental Technician
AS	Aviation Support Equipment Tech.	EA	Engineering Aid
ASE	Aviation Support Equipment Technician (Electrical)	EM	Electrician's Mate
ASH	Aviation Support Equipment Technician (Hydraulics & Structures)	EN	Engineman
ASM	Aviation Support Equipment Technician (Mechanical)	EO	Equipment Operator
AT	Aviation Electronics Technician	EQ	Equipmentman (E-9 only)
AV	Avionics Technician (E-9 only)	ET	Electronics Technician
AW	Aviation Antisubmarine Warfare Operator	ETN	Electronics Technician (Unknown)
AX	Aviation Antisubmarine Warfare Technician	ETR	Electronics Technician (Unknown)
AZ	Aviation Maintenance Administrationman	EW	Electronics Warfare Technician
		FN	Fireman
		FT	Fire Control Technician
		FTB	Fire Control Technician (Ballistic Missile Fire Control)
		FTG	Fire Control Technician (Gun Fire Control)
		FTM	Fire Control Technician (Surface Missile Fire Control)

Table III-4 (Concluded)

Rating	Description	Rating	Description
GM	Gunner's Mate	STG	Sonar Technician (Surface)
GMG	Gunner's Mate (Guns)	STS	Sonar Technician (Submarine)
GMM	Gunner's Mate (Missiles)	SW	Steelworker (includes CUCM)
GMT	Gunner's Mate (Technician)	TD	Tradesman
GS	Gas Turbine System Technician	TM	Torpedoman's Mate
GSE	Gas Turbine System Technician (Electrical)	UT	Utilitiesman
GSM	Gas Turbine System Technician (Mechanical)	YN	Yeoman
HM	Hospital Corpsman		
HN	Hospitalman		
HT	Hull Maintenance Technician		
IC	Interior Communications Electrician (includes EMCM)		
IM	Instrumentman (includes PICM)		
IS	Intelligence Specialist		
JO	Journalist		
LI	Lithographer		
LN	Legalman		
MA	Master-At-Arms		
ML	Molder		
MM	Machinist's Mate		
MN	Mineman		
MR	Machinery Repairman		
MS	Mess Management Specialist		
MT	Missile Technician		
MU	Musician		
NC	Navy Counselor		
OM	Opticalman (includes PICM)		
OS	Operations Specialist		
OT	Ocean Systems Technician		
PC	Postal Clerk		
PH	Photographer's Mate		
PI	Precision Instrumentman (E-9 only)		
PM	Patternmaker (includes MLCM)		
PN	Personnelman		
PO	Petty Officer		
PR	Aircrew Survival Equipmentman		
PT	Photo Intelligence Technician		
QM	Quartermaster		
RM	Radioman		
RP	Religious Program Specialist		
SD	Steward		
SH	Ship's Serviceman		
SK	Storekeeper		
SM	Signalman		
SN	Seaman		
ST	Sonar Technician		

Table III-5

CIVILIAN WHITE-COLLAR OCCUPATIONAL CODE GROUPS

Occupational Code Group*	Description
0	Miscellaneous Occupations
1	Social Science, Psychology and Welfare
2	Personnel Management and Industrial Relations
3	General Administrative, Clerical, and Office Services
4	Biological Sciences
5	Accounting and Budget
6	Medical, Hospital, Dental, and Public Health
7	Veterinary Medical Science
8	Engineering Architecture
9	Legal and Kindred
10	Information and Arts
11	Business and Industry
12	Copyright, Patent, and Trade-Mark
13	Physical Sciences
14	Library and Archives
15	Mathematics and Statistics
16	Equipment, Facilities, and Service
17	Education
18	Investigation
19	Quality Assurance, Inspection, and Grading
20	Supply
21	Transportation
22	Unspecified
23	Postal Operations

* Group members should be multiplied by 100 to correspond with group numbers in Reference 8.

Table III-6

CIVILIAN BLUE-COLLAR OCCUPATIONAL CODE GROUPS

Occupational Code Group*	Description
25	Wire Communication Equipment Installation and Maintenance
26	Electronic Equipment Installation and Maintenance
27	Quartz Crystal Work
28	Electrical Installation and Maintenance
29	Electronic Equipment Operation
31	Fabric and Leather Work
32	Glass Work
33	Instrument Maintenance
34	Machine Tool Work
35	Manual Labor
36	Masonry, Plastering, and Roofing
37	Metal Processing
38	Metal Work
39	Motion Picture, Radio, Television, and Sound Recording Equipment Work
40	Optical Work
41	Painting and Paperhanging
42	Pipefitting
43	Plastic Work
44	Printing and Reproduction
45	Rubber Work
46	Woodwork
47	General Maintenance and Operations
48	General Equipment Maintenance
50	Agriculture, Forestry and Kindred
52	Miscellaneous Occupations
53	Fixed Industrial Maintenance
54	Fixed Industrial Equipment Operation
55	Quarry Work
56	Currency, Securities, Coin, and Medal Making
57	Mobile Industrial Equipment Operations
58	Mobile Industrial Equipment Maintenance
59	Marine Operations
60	Railroad Operations
61	Railroad Maintenance
62	Marine Maintenance
65	Ammunition and Explosives
66	Armament Work
67	Manufacture and Repair Shop Operations
69	Warehousing

Table III-6 (Concluded)

Occupational Code Group*	Description
70	Packing and Processing
73	Laundry and Dry Cleaning
74	Food Preparation and Serving
75	Medical Services
76	Merchandising and Personal Services
77	Animal Caretaking
82	Fluid Systems
83	Instrumentation
84	Reclamation Work
85	Aircraft Propeller Overhaul
86	Aircraft Engine Overhaul
87	Manufacturing, Repair and Industrial Support Supervision
88	Aircraft Overhaul
90	Film Processing
99	Blue-Collar Unspecified

* Group members should be multiplied by 1000 to correspond with group numbers in Reference 9.

C. Basic Personnel Utility Data Base

The basic personnel utility data base was derived from utility tables contained in the Decisions and Design, Inc. report on accrued utility of Navy enlisted personnel.⁴ This report presents the results of a study conducted to determine the relative contribution to navy missions of the accrued experience of enlisted personnel. The report identifies seven groupings of EP ratings from which relative utility data were generated. The utility groupings and numbers obtained were derived from analysis of interviews conducted with several experienced officers and petty officers, representing a fairly broad spectrum of duty types and service experience. Although these utility data were considered as being approximate in nature and not intended to be used for comparisons among EP ratings, it was felt that they did provide a sufficient and useful data base for the purposes of this analysis.

The utility groupings established in that report are as follows, where the EP ratings used are as defined previously in Table III-4:

Group A - FT, ST

Group B - AD, AQ, AT, AX, CTT, ES, ET, EW, GM, MT

Group C - ABE, AE, AM, AO, AW, BM, BT, CTM, EN, GS, HT, MM,
MN, TD, TM

Group D - ABF, ABH, AS, CTI, CTO, CTR, IS, OS, OT, PR, QM, RM

Group E - CTA, HM, IM, ML, MR, OM, PM, SM, YN

Group F - AG, AK, AZ, BU, CE, CM, DK, DP, DT, EA, EO, LN, MA,
MS, NC, PN, SK, SW, UT

Group G - DM, JO, LI, MU, PC, PH, SH

Utility values were established in a range from 0 to 100, and were tabulated for each utility group in arrays representing pay grade and length of service. For this analysis, the length of service variable was eliminated by choosing the maximum utility value for a pay grade over the various years of service. The resulting Personnel Utility Data Base obtained in this manner is presented in Table III-7.

Table III-7
BASIC PERSONNEL UTILITY DATA BASE

Pay Grade	Utility Group						
	A	B	C	D	E	F	G
E-1	11	11	11	11	11	10	8
E-2	19	20	20	20	20	14	10
E-3	29	29	29	29	29	19	14
E-4	52	52	52	43	38	22	14
E-5	67	67	67	52	48	31	17
E-6	81	81	81	62	52	31	17
E-7	95	90	81	67	57	38	21
E-8	100	95	86	73	63	42	21
E-9	100	95	86	73	63	42	21

IV METHODOLOGY

This chapter describes the methodology that was developed to provide a basis for examining the effects of personnel shortfalls on Navy personnel readiness relative to logistics support functions. This methodology is constrained by the availability of the input data bases as discussed in the previous chapter. The methodology is based on the establishment of a definition of personnel readiness in terms of the relative utility of personnel assigned to specific billets within the Navy manpower structure. Section A of this chapter provides the details of this definition of personnel readiness. Sections B and C describe the transformations and expansions of the basic data bases (as described in Sections III.B and C) that were required to satisfy the needs of the methodology. Section D then develops a modified utility evaluation concept that provides a basis for optimizing Navy-wide personnel readiness across the various Naval activities under different levels of personnel shortfalls among officers, enlisted personnel, and civilians. Section E describes a computer program designed to optimize Navy-wide personnel readiness under specific levels of personnel shortfall through the implementation of the modified utility evaluation concept.

A. Personnel Readiness

Personnel readiness is a factor that addresses the availability of sufficient, qualified personnel to perform the required objectives of a Naval organizational unit or activity to perform its assigned mission responsibilities. A measure of personnel readiness must consider not only the availability of the required numbers of officers, petty officers, other enlisted personnel, and civilians within an organizational unit or

activity, but also the maintenance of a proper balance of these personnel with respect to mission essential skills, training, and Naval experience. The personnel authorizations contained in the ship and aircraft squadron manpower documents, and the SHORSTAMPS/SHOROC manpower planning program provide the standards for measuring personnel readiness strictly on a numerical basis. That is, if a unit or activity is staffed strictly in accordance with its authorization, then that unit or activity can be considered to possess a 100% rating for personnel readiness. Deviations from these authorizations, especially in the sense of shortfalls, will degrade personnel readiness, although the amount of degradation will be highly dependent upon the specific areas where the shortfalls occur. That is, the loss of one storekeeper from a total of ten authorized may have a lower degradation effect than the loss of one sonar technician from a total of only four. Thus, the procedure used to determine personnel readiness degradations from the standard must consider the full spectrum of the established personnel authorizations.

The approach used in this analysis is based on the assignment of utility values to the various personnel billets authorized to an activity.* The personnel readiness standard for an activity is its authorized utility and is computed as the sum of the utilities of each authorized billet for that activity. In the event of deviations from an activity's authorized billet structure, personnel readiness is then defined as the ratio of achieved utility to authorized utility. That is,

$$\text{Personnel Readiness} = \frac{\text{Achieved Utility}}{\text{Authorized Utility}} \quad (\text{IV-1})$$

* For the remainder of this report, the term 'activity' will be used to refer to either an organizational unit (ship or aircraft squadron) or a shore activity (shore mission area).

where achieved utility is computed as the sum of the utilities of the assigned personnel to that activity. In the unlikely cases of overstaffing or overqualified personnel filling some billets, the achieved utility could exceed the authorized utility. In such cases, personnel readiness would be assigned a value of unity. However, this analysis is concerned solely with the effects of shortfalls on personnel readiness and thus achieved utility will always be less than authorized utility. Personnel readiness, as defined by Eq. IV-1, can be used for a single activity, a group of activities (such as all surface ships), or the entire Navy. It also can apply to specific functional segments of the Navy such as maintenance operations or supply operations.

B. Personnel Utility Data Base Expansion

The expansion of the Personnel Utility Data Base for use in this analysis first required assigning each officer designator, EP rating, and civilian occupational code group to one of the seven utility skill groups identified in the basic utility data base, described previously in Section III.C. These utility skill group assignments were based on our knowledge of the functions required of the various designators, ratings and occupational codes and the manner in which they relate to the utility skill group's primary characteristics as given by the following:

Group A: Operate complex weapons systems, make quick decisions, requires extensive formal and on-the-job training.

Group B: Operate or maintain complex equipment, requires extensive formal and on-the-job training.

Group C: Operate or maintain equipment of intermediate level of complexity, requires some formal training and much on-the-job training.

Group D: Operate or maintain less complex support equipment and perform less technical tasks than ratings in Groups A, B and C, requires some formal and on-the-job training.

Group E: Perform administrative and support functions with some combat role requirements.

Group F: Perform administrative and support functions with little combat role requirements.

Group G: Perform useful support functions with no combat role requirements.

The resulting assignments are presented in Table IV-1.

The next step in the expansion of the data base required the establishment of utility pay grades that include representation of the full spectrum of officer, EP and civilian pay grades. This equivalencing of pay grades was based on the equivalent grade schedules used by the Naval Facilities Engineering Command in planning quarters and messing facilities for officers, enlisted personnel, and civilians.¹³ Table IV-2 presents a listing of the utility pay grades and the equivalency relationships with officer, EP, and the the four civilian pay grades.

The final step in expanding the Personnel Utility Data Base was to expand and normalize the utility tables contained in the Basic Personnel Utility Data Base (Table III-7) which only consider the nine EP pay grades. This was accomplished by fitting least-squares lines to the basic data for utility pay grades 1 to 9 (E-1 to E-9) for each utility skill group and then normalizing the values to equal unity for the highest utility obtained for the least-squares extrapolation (Pay Grade 18 for Skill Group A).

The resulting normalized utility values used in this analysis for the various utility skill groups and pay grades are presented in Table IV-3.

C. Personnel Data Base Transformations

The personnel data base transformations were accomplished in two stages. First, the basic personnel data bases were transformed into equivalent formats, and then all four data bases were combined into a single utility structured personnel data base, one for each of the logistics functional areas addressed in this analysis, in addition to one addressing the full spectrum of Naval operations. These transformations are discussed, in turn, in the remainder of this section.

Table IV-1

UTILITY SKILL GROUP ASSIGNMENTS

Utility Skill Group	Aggregated Officer * Designators	EP Ratings †	Civilian White Collar Occupational** Code Groups	Civilian Blue-Collar Occupational Code Groups††
A	111X, 112X, 116X, 117X, 130X, 131X, 139X	FT, FTB, FTG, FTM, ST, STG, STS	None	None
B	100X, 105X, 110X, 113X, 114X, 118X, 119X, 132X, 137X, 152X, 7XXX, 8XXX	AG, AD, ADJ, ADR, AF, AN, AQ, AT, AV, AX, CTT, ET, ETN, ETR, EW, GM, GNC, GNM, GMT, MT, SN	None	None
C	140X, 141X, 144X, 146X, 150X, 151X	AB, ABE, AE, AM, AME, AMH, AMS, AO, AW, BM, BT, CT, CTM, EN, GS, GSE, GSM, HT, MM, MN, TD, TM	None	None
D	161X, 163X, 164X, 6XXX	ABF, ABH, AS, ASE, ASH, ASM, CTI, CTO, CTR, EM, IC, IS, OS, OT, PI, PR, PT, QM, RM	None	25, 26, 33, 40, 65, 66, 82, 83, 85, 86, 88
E	191X, 192X, 210X, 220X	APD, BR, CTA, DN, FN, HM, HN, IM, ML, MR, OM, PM, SM, YN	8, 11, 15	27, 28, 29, 57, 58, 59, 62, 67
F	180X, 193X, 230X, 290X, 310X, 510X	AG, AK, AZ, BU, CE, CM, CU, DK, DP, DT, EA, EO, EQ, LN, MA, MS, NC, PN, PO, SK, SW, UT	2, 3, 4, 5, 6, 16, 17, 19, 20, 21	34, 37, 38, 43, 45, 47, 48, 53, 54, 60, 61, 69, 87, 90
G	165X, 167X, 168X, 169X, 194X, 195X, 196X, 197X, 250X, 410X	DM, JO, LI, MU, PC, PH, RP, SD, SH	0, 1, 7, 9, 10, 12, 14, 18, 22, 23	31, 32, 35, 36, 39, 41, 42, 44, 46, 50, 52, 55, 56, 70, 73, 74, 75, 76, 77, 84, 99

* Aggregated Officer Designators are defined in Table III-3

† EP Ratings are defined in Table III-4

** Civilian White-Collar Occupational Code Groups are defined in Table III-5

†† Civilian Blue-Collar Occupational Code Groups are defined in Table III-6

Table IV-2
UTILITY PAY GRADE EQUIVALENCIES

Utility Pay Grade	Officer Pay Grades	EP Pay Grades	Civilian Pay Grades *			
			GS	WS	WL	WG
1		E-1	GS-0, GS-1			WG-1, WG-2
2		E-2	GS-2			WG-3, WG-4
3		E-3	GS-3			WG-5, WG-6
4		E-4	GS-4			WG-7, WG-8
5		E-5	GS-5	WS-1	WL-1	WG-9
6		E-6		WS-2, WS-3	WL-2	
7		E-7		WS-4	WL-3	WG-10
8		E-8	GS-6	WS-5, WS-6	WL-4	
9		E-9		WS-7	WL-5	WG-11
10	0-1, W-1, W-2		GS-7	WS-8, WS-9	WL-6, WL-7, WL-8	WG-12, WG-13
11	0-2, W-3, W-4		GS-8, GS-9	WS-10, WS-11	WL-9, WL-10, WL-11	WG-14
12	0-3		GS-10, GS-11	WS-12, WS-13	WL-12, WL-13, WL-14	WG-15
13	0-4		GS-12	WS-14, WS-15, WS-16	WL-15	
14	0-5		GS-13, GS-14	WS-17, WS-18, WS-19		
15	0-6		GS-15			
16			GS-16			
17	0-7 thru 0-11		GS-17			
18			GS-18			

* GS - General Schedule; WS-Federal Wage System, Supervisory; WL- Federal Wage System Leader;
WG- Federal Wage System, Non-Supervisory

Table IV-3

NORMALIZED UTILITY VALUES

Utility Pay Grade	Utility Skill Group						
	A	B	C	D	E	F	G
1	.049	.049	.049	.049	.049	.044	.035
2	.088	.088	.088	.088	.088	.062	.044
3	.128	.128	.128	.128	.128	.084	.053
4	.230	.230	.230	.190	.168	.097	.062
5	.296	.296	.296	.230	.212	.122	.069
6	.358	.358	.327	.274	.230	.137	.075
7	.420	.398	.358	.296	.252	.168	.084
8	.442	.420	.380	.323	.278	.186	.093
9	.496	.475	.438	.359	.307	.199	.100
10	.552	.526	.484	.396	.337	.218	.108
11	.608	.580	.531	.433	.367	.237	.115
12	.664	.632	.577	.470	.397	.256	.123
13	.720	.684	.624	.507	.427	.275	.130
14	.776	.737	.670	.544	.457	.294	.138
15	.832	.790	.717	.581	.487	.313	.145
16	.888	.842	.763	.618	.517	.332	.153
17	.944	.895	.810	.655	.574	.351	.160
18	1.000	.947	.856	.692	.577	.370	.168

The basic personnel data bases established for use in this analysis, as described in the preceding chapter, were formatted in terms of the basic data sources and thus were not consistent with one another. For example, on one hand, the three sea-based personnel data bases listed officers only up through grade O-10, while the shore-based personnel data base listed officers on up through grade O-11 and included a space for Commodores between grades O-6 and O-7. On the other hand, the sea-based personnel data bases listed designated strikers, with their associated NICs, separately from other E-3 pay grade personnel, while the shore-based personnel data base did not consider this distinction.

The required data base transformations to rectify these and other inconsistencies were accomplished by the use of two computer programs: AFLALT for the afloat forces and SHALT for the shore-based personnel. These programs also expanded the data bases to include a utility skill group and functional area identification for each officer, EP and civilian position record in the respective data base. The applicable utility skill groups were identified in the previous subsection. The functional area identifications were established on a judgmental basis, considering the relationships between the associated job titles and the functional area designations. The resulting identifications are presented in Table IV-4.

The results of the AFLALT and SHALT runs produced the revised personnel data bases MDNEW, SSNEW, SQNEW and SHNEW derived respectively from the data bases MDFILE, SSFILE, SQFILE and SHFILE, which were described in Section III.B. Figure IV-1 presents an excerpt from the revised Shore Mission Area Personnel Data Base (SHNEW). This figure portrays the officer, enlisted and civilian manpower allocations to the Environmental Support Mission Area (ENV). The format shown in the figures is the same for all four new data bases. The differences in the data base format as compared with the old data base format shown in Figure III-4 for the same mission area are as follows:

Table IV-4

FUNCTIONAL AREA IDENTIFICATIONS

Functional Area	Aggregated Officer Designators *	EP Ratings †	Civilian White-Collar Occupational Code Groups **	Civilian Blue-Collar Occupational Code Groups ††
Operations	110X, 111X, 112X, 113X, 114X, 116X, 117X, 118X, 119X, 130X, 131X, 132X, 137X, 139X, 7XXX, 8XXX	AB, ABE, ABF, ABH, AC, AN, AO, APO, BM, CT, CTA, CTI, CTO, CTR, CTT, EM, EN, EO, GN, GNG, GMM, GMT, IS, OS, QM, RM, SM, SN	None	None
Maintenance	140X, 141X, 144X, 146X, 150X, 151X, 152X, 6XXX	AD, ADJ, ADR, AE, AF, AM, AME, AMH, AMS, AQ, AS, ASE, ASH, ASH, AT, AV, AX, AZ, BR, BT, BU, CE, CM, CTM, CU, DM, DS, EA, EQ, ET, ETN, ETR, EW, FN, FT, FTB, FTG, FTM, GS, GSE, GSM, HT, IC, IM, ML, MM, MN, MR, MT, OM, OT, PI, PH, PR, PT, ST, STG, STS, TM, UT	0, 16, 22	25, 26, 27, 28, 31, 32, 33, 34, 36, 37, 38, 40, 41, 42, 43, 45, 46, 47, 48, 53, 54, 61, 62, 66, 67, 82, 83, 84, 85, 86, 88
Own-Unit Support	100X, 105X, 161X, 163X, 164X, 165X, 167X, 168X, 169X, 180X, 191X, 192X, 193X, 194X, 195X, 196X, 197X, 210X, 220X, 230X, 250X, 290X, 410X, 510X	AG, DK, DN, DP, DT, HM, HN, JO, LI, LN, MA, MU, NC, PC, PH, PN, PO, RP, YN	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 23	29, 35, 39, 44, 50, 52, 56, 73, 74, 75, 76, 77, 90, 99
Supply	310X	AK, AW, MS, SD, SH, SK, TD	19, 20, 21	55, 57, 58, 59, 60, 65, 69, 70, 87

* Aggregated Officer Designators are defined in Table III-3

† EP Ratings are defined in Table III-4

** Civilian White-Collar Occupational Code Groups are defined in Table III-5

†† Civilian Blue-Collar Occupational Code Groups are defined in Table III-6

[illegible]

Figure IV-1 SAMPLE SECTION - NEW SHORE MISSION AREA PERSONNEL DATA BASE (SHNEW)

- For all position records, column 6 denotes the utility skill group and column 8 the functional area identified with the job code identifier in columns 1-4. The numerical equivalencies for the utility skill groups are; 1 = A, 2 = B, 3 = C, 4 = D, 5 = E, 6 = F, and 7 = G: and for the functional areas, these are 1 = Operations, 2 = Maintenance, 3 = Own-Unit Support, and 4 = Supply.
- All officer pay grades in the Admiral and Commodore category (Commodore and 0-7 through 0-11) are combined into a single Admiral category, denoted as 0-7 and these combined allocations appear in columns 10-13. Thus the officer allocation columns begin with Pay Grade 0-7 and proceed downward to Pay Grade 0-1, followed by Pay Grades W-4 down to W-1, with the final column denoting the total number of officer billets for that position record.

For the sea-based personnel data bases, the changes made were as follows:

- Added the utility skill group and functional area identifiers to each position record.
- Combined officer designators in terms of the aggregate officer designators as defined in Table III-3.
- Combined all Admiral pay grades (0-7 through 0-10) into a single Admiral category (0-7).
- Combined designated strikers and E-3s into a single category (E-3).
- Combined all airman (AN), fireman (FN), and seaman (SN) allocations into the respective categories, eliminating the specification of NICs.
- Revised the number of officer designators and EP rating entry specifications and expanded the civilian entry specifications to include the four civilian pay grades, with all civilian entry specifications being set to zero.

The second stage in the data transformation procedure involved combining the four personnel data bases into a single utility structured personnel data base, generating one such data base for each of the logistics functional areas (designated logistics, maintenance, own-unit support, and supply) and also one

covering the entire Navy. These transformations were accomplished by use of the computer programs UTIALL, UTILOG, UTIMAI, UTIOUS, and UTISUP, where the latter five programs were simple modifications of the primary program UTIALL. The use of these programs resulted in the generation of five utility structured personnel data bases, designated by the same acronyms as their respective generating program.

Figure IV-2 presents an excerpt of the utility structured data base UTIALL. This figure portrays the officer, enlisted, and civilian manpower allocations to the Environmental Support Mission Area (ENV), broken down into utility skill groups and pay grades, for the shore-based Navy population. The first record shown on the figure specifies the mission area (Columns 1-9); the force class type (Column 14); the number of applicable aggregated officer designator entries (Columns 15-16); the number of applicable EP ratings (Columns 17-19); and the number of applicable civilian occupational code groups, broken down in terms of the GS pay plan (Columns 20-21), the WS pay plan (Columns 22-23), the WG pay plan (Columns 24-25), and the WL pay plan (Columns 26-27). The next set of records each specify the utility skill group for officers, the number of officers per utility pay grade for that utility skill group (18 pay grades), and finally the total number of officers for that utility skill group. The officer set of entries is terminated with a skill group entry '0000', followed by the column totals for each utility pay grade and finally the total number of officers allocated to the activity. The remaining sets of entries provide similar information with respect to enlisted personnel and the four civilian pay plans, with the terminating records for each set being given the respective skill group entries of 'EEEE', 'GSGS', 'WSWS', 'WGWG', and 'WLWL'. For the activity (ENV) shown in the figure, there are no WL civilian pay plan personnel allocated, as indicated by the zero entry in the first record for that pay plan (Columns 26-27), so that there is no set of records for the WL pay plan.

D. Modified Utility Evaluation Concept

The authorized utility for an activity is defined as the sum of the utilities of each authorized billet. If we let a denote the activity index, i the utility skill group index, and j the utility pay grade index, then activity a 's authorized utility, denoted by AU_a is given as follows:

$$AU_a = \sum_{i=1}^7 \sum_{j=1}^{18} u_{ij} n_{ija} \quad (IV-2)$$

where u_{ij} = the utility value associated with skill group i and pay grade j

and n_{ija} = the number of personnel authorized to activity a in skill group i with pay grade j .

If A denotes the total number of activities in the Navy, then the Navy-wide authorized utility AU_{tot} is given by the following equation:

$$AU_{tot} = \sum_{a=1}^A AU_a \quad (IV-3)$$

Substituting Eq. IV-2 for AU_a and rearranging the summation signs, Eq. IV-3 can be rewritten as follows:

$$AU_{tot} = \sum_{i=1}^7 \sum_{j=1}^{18} u_{ij} \sum_{a=1}^A n_{ija} \quad (IV-4)$$

If shortfalls exist with respect to Naval personnel, then the numbers of assigned personnel to the activities, denoted by x_{ija} , will in some cases be less than that authorized. That is, $x_{ija} < n_{ija}$ for some values of i and j . Eq. IV-4 could be used to compute achieved utility, with x_{ija} replacing n_{ija} . However, this representation would not reflect the relative value of the loss of specific personnel between different activities. That is, the loss of one person in skill group i and pay grade j from an activity authorized 100 persons in that skill group/pay grade

combination would have the same degrading effect on Navy-wide achieved utility as the loss of one such person from an activity that is authorized only two such persons. The modified utility evaluation concept used in this analysis presents an alternative approach that considers the relative utility of personnel of the same skill group/pay grade combination assigned to activities with different authorized strengths for that particular combination.

The modified concept assumes that the utility value associated with the loss of one person within a skill group/pay grade combination for an activity increases linearly with the number of such personnel losses, while the sum of these utilities remains the same as if each person were assigned the same utility value as that used in determining the authorized utility for that activity. If we let U_{ija} denote the authorized utility associated with the skill group i /pay grade j combination for activity a , then

$$U_{ija} = u_{ija} n_{ija} \quad (\text{IV-5})$$

where each person is assigned a utility value of u_{ija} . Under the modified concept, person x_{ija} would be assigned a utility value $u_{ija}^*(x_{ija})$ given by the following equation.

$$u_{ija}^*(x_{ija}) = \frac{2(n_{ija} - x_{ija} + 1)}{n_{ija} + 1} u_{ij} \quad (\text{IV-6})$$

For example, suppose that a certain activity is authorized 10 persons within a specific skill group/pay grade combination that has an associated utility per person value of 0.5. Then the total authorized utility for that activity's skill group/pay grade combination is 5.0, with each person being assigned a utility value of 0.5. Under the modified concept, the x^{th} person would be assigned the utility value as shown in the following table:

x	Utility
1	.909
2	.818
3	.727
4	.636
5	.545
6	.455
7	.364
8	.273
9	.182
10	.091
Total	5.000

Thus, losing the first person out of 10 ($x=10$) would result in utility loss of .091, whereas the loss of the last person ($x=1$) would result in an additional utility loss of .909. Note that the total sum of the utility values is 5.0, the same as the authorized utility for that activity.

The use of the modified utility evaluation concept would result in the achieved utility of an activity, denoted by U_a , to be computed by the following equation:

$$U_a = \sum_{i=1}^7 \sum_{j=1}^{18} \sum_{k=1}^{X_{ija}} u_{ija}^*(k) \quad (\text{IV-7})$$

where X_{ija} denotes the number of personnel in the utility skill group/pay grade combination (i,j) assigned to activity a and $u_{ija}^*(k)$ is as given in Eq. IV-6 with $k=x_{ija}$. Thus the personnel readiness for activity a , denoted by R_a , would be determined as follows:

$$R_a = \frac{U_a}{AU_a} \quad (\text{IV-8})$$

where U_a and AU_a are as given respectively in Eq. IV-7 and Eq. IV-2. Navy-wide personnel readiness, denoted by R_N , would then be determined by the following equation:

$$R_N = \frac{\sum_{a=1}^A U_a}{\sum_{a=1}^A AU_a} \quad (\text{IV-9})$$

E. Utility Optimization Computer Program

The Utility Optimization Computer Program, designated by the acronym UALLOC, was designed to optimize Navy-wide personnel readiness for various levels of shortfalls among the six different pay categories (officers, enlisted personnel, and the four civilian pay plans) under minimum manning level restrictions specified for the four different force groups (surface ships, subsurface ships, aircraft squadrons, shore mission areas). The program was designed to operate with any one of the five utility structured personnel data bases established for this analysis, as described previously in Section IV.C. Thus, the program can provide optimal allocations for the entire Navy, as well as for the restricted segments representing designated logistics, maintenance, own-unit support, and supply.

The expanded Personnel Utility Data Base, described previously in Section IV-B, is built into the program. The first function of the program then is to read in the Force Structure Data Base, which is the same as that described in Volume I of this report. This data base simply lists the number of active activities of each type within the Navy force structure. That is, the number of ships of each class, the number of aircraft squadrons of each type, and the number of shore mission areas of each type. The program then reads in the specific Utility Structured Personnel Data Base to be subjected to analysis and computes the authorized personnel allocations and utilities for each activity, as well as those for the larger subgroups of surface ships, subsurface ships, aircraft squadrons, shore mission

areas, and ultimately the entire Navy. The next step the program performs is to read in the specific case inputs which consist of the minimum required manning levels for the four force groups and the percentages of shortfall for each pay scale (officers, enlisted personnel, and the four civilian pay plans.)

Having read in all the inputs, the program then performs its major function of determining the activity allocations, under the shortfall and minimum manning level conditions prescribed, that optimize achieved Navy-wide utility, or equivalently, Navy-wide personnel readiness. This is accomplished through repeated use of the subroutine OPUTIL. This subroutine operates on a specific pay scale/skill group/pay grade combination and minimizes its Navy-wide utility degradation for the specified personnel shortfall, under the restricted minimum manning level requirements. The subroutine uses an iterated Lagrange Multiplier procedure to accomplish the utility minimizations. The essence of this procedure is as follows.

Consider a specific pay scale/skill group/pay grade combination. Let n_a denote the number of personnel authorized to activity a for that specific combination and u denote the assigned utility value for that combination. If we let x_a denote the shortfall for activity a, then the utility degradation $\Delta U_a(x_a)$ for that activity, under the modified utility evaluation concept described in the preceding section is given as follows:

$$\Delta U_a(x_a) = \sum_{i=1}^{x_a} \frac{2u_i}{(n_a+1)} \quad (\text{IV-10})$$

This equation follows from Eq. IV-6, where $u = u_{ij}$, $n_a = n_{ija}$, and $i = n_{ija} - x_{ija} + 1$ for each person up to the x_a^{th} person from the bottom. If we let S denote the shortfall specified for the pay scale group under consideration and m_a denote the minimum manning level specified for activity a, then the problem can be specified as follows:

$$\text{Minimize} \quad \sum_{a=1}^A \Delta U_a(x_a) \quad (\text{IV-11})$$

subject to

$$\sum_{a=1}^A x_a = S \quad (\text{IV-12})$$

and

$$0 \leq x_a \leq n_a - m_a \quad (\text{IV-13})$$

The solution procedure involved for this problem is based on an iterated Lagrange Multiplier solution to Eqs. IV-11 and IV-12. The Lagrange solution to this unrestricted problem is given as follows:

$$x_a = \frac{\lambda - c_a}{2c_a} \quad (\text{IV-14})$$

where

$$c_a = \frac{u}{n_a + 1} \quad (\text{IV-15})$$

and

$$\lambda = \frac{2S + A}{\sum_{a=1}^A c_a^{-1}} \quad (\text{IV-16})$$

If the solution values of x_a given by Eq. IV-14, all meet the conditions specified by Eq. IV-13, then that represents the optimum solution. If the conditions of Eq. IV-13 are not satisfied for all a , then the following problem modifications are invoked:

- (1) If $x_a < 0$, then x_a is set equal to zero and activity a is withdrawn from the problem, with A being reduced by one.
- (2) If $x_a > n_a - m_a$, then x_a is set equal to $n_a - m_a$ and activity a is withdrawn from the problem, with A being reduced by one and S being reduced by x_a .

With the above problem modifications invoked, the solution procedure is then reapplied. This iteration procedure continues until all x_a satisfy the conditions of Eq. IV-13. In the event that all activities have been withdrawn in accordance with (1) or (2) above and Eq. IV-12 is not satisfied, then the manning level restrictions to the problem are too strict. In this case, the values of m_a are set equal to zero and the solution procedure is then initiated for this new problem, where all activities are reinstated into the problem.

When the optimal allocations have been completed, the program then computes the remaining summary outputs. These include the resulting personnel allocations and achieved utilities for each activity, in addition to the ratios of assigned personnel to authorized personnel (personnel availability) and achieved utility to authorized utility (personnel readiness) for each activity. The outputs also include the same as the above for the four force groups (surface ships, subsurface ships, aircraft squadrons and shore mission areas), in addition to the entire Navy.

A sample output table is presented in Figure IV-3. This table presents the results for a UALLOC run using the data base UTILOG (designated logistics) where the personnel shortfalls are assumed as 20% ($SF=.20$) for all pay scales and the minimum manning levels are assumed as 80% for the afloat forces and 70% for the shore mission areas ($ML=.8, .7$). The table headings are, for the most part, self-explanatory. The exceptions are NIF, which denotes the number of units of that activity in the force structure assumed, and T, which specifies the activity's force class type (S= surface ship, U=subsurface ship, A= aircraft squadron, and L = shore mission area).

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Figure IV-3 SAMPLE UALOC OUTPUT TABLE

[illegible]

ACTIVITY CODE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	12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V SAMPLE APPLICATION AND CRITIQUE OF METHODOLOGY

This chapter presents the results of an application of the methodology described in the preceding chapter to evaluating the ramifications of personnel shortfalls on Naval logistics personnel readiness. Section A presents the results and analysis of a number of computer runs of the Utility Optimization Computer Program (UALLOC) applied to several levels of personnel shortfalls across the broad spectrum of Navy manpower authorizations. This analysis illustrates the use of the methodology developed and also provides insights to the advantages and disadvantages of this type of approach to evaluating Navy logistics personnel readiness relative to the existence of personnel shortfalls. Section B then presents a critique of the proposed approach, indicating areas on which the methodology could be improved to provide a more useful tool to evaluating logistics personnel readiness under various levels of personnel shortfalls within the Navy manpower structure.

A. Sample Application of Methodology

The sample application of the use of the methodology developed is based on a set of 60 computer runs of the Utility Optimization Computer Program (UALLOC) described previously in Section IV.E. For each of the five utility structured data bases, representing respectively the entire Navy and the four logistics functional areas (designated logistics, maintenance, own-unit support, and supply), four different levels of shortfalls (5%, 10%, 15%, and 20%) were assumed under three different manning level restriction assumptions (no minimum manning level requirements; 80% minimum manning level requirements for afloat forces with 70% minimum manning level requirements for ashore forces; and 90% minimum manning level requirements for afloat

forces with 70% minimum manning level requirements for ashore forces). The results of the computer runs consisted of 60 tables similar in nature to that illustrated in Figure IV-2 of the previous chapter.

Tables V-1 to V-5 present summaries of the results obtained under no minimum manning level requirements where the basic populations assumed in the tables are respectively the entire Navy, the designated logistics functional area, the maintenance functional area, the own-unit support functional area, and the supply functional area. These summary results present the officer, enlisted, and civilian (where applicable) availabilities and the personnel readiness values for the five force groups (surface ships, subsurface ships, aircraft squadrons, shore mission areas, and total Navy) under the four different shortfall levels assumed.

The results shown in the summary tables indicate relatively insignificant differences among the values obtained for the five different base populations (entire Navy, designated logistics, etc.). The force group personnel readiness values generally adhere to those that could theoretically be predicted, as indicated in the table below. The theoretical predictions are based on the shortfalls being assessed against a single utility skill group/pay grade combination with an authorized strength of 100 personnel. The fact that these personnel readiness values are relatively high in comparison with the associated shortfalls is

Shortfall Percentage	Computed Personnel Readiness		Theoretical Prediction
	Minimum	Maximum	
5	.996	1.000	.997
10	.986	1.000	.986
15	.971	.995	.976
20	.948	.978	.958

Table V-1

SUMMARY OF PERSONNEL AVAILABILITY
AND READINESS WITH NO MANNING LEVEL RESTRICTIONS
BASIC POPULATION - ENTIRE NAVY

Force Group	Availability/Readiness Category	Percent Shortfall			
		5	10	15	20
Surface Ships	Officer Availability	.978	.940	.896	.848
	Enlisted Availability	.957	.907	.857	.806
	Personnel Readiness*	.997	.988	.974	.954
Subsurface Ships	Officer Availability	1.000	.977	.930	.879
	Enlisted Availability	.993	.955	.907	.852
	Personnel Readiness*	.999	.992	.978	.957
Aircraft Squadrons	Officer Availability	.967	.922	.872	.821
	Enlisted Availability	.964	.916	.866	.814
	Personnel Readiness*	.997	.988	.973	.953
Shore Mission Areas	Officer Availability	.937	.881	.830	.779
	Enlisted Availability	.936	.883	.834	.785
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.996	.987	.974	.955
Total Navy	Officer Availability	.950	.900	.850	.800
	Enlisted Availability	.950	.900	.850	.800
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.997	.988	.974	.955

* Personnel readiness computed in accordance with modified utility evaluation concept described in Section IV.D

Table V-2

SUMMARY OF PERSONNEL AVAILABILITY
AND READINESS WITH NO MANNING LEVEL RESTRICTIONS
BASIC POPULATION - DESIGNATED LOGISTICS

Force Group	Availability/Readiness Category	Percent Shortfall			
		5	10	15	20
Surface Ships	Officer Availability	.989	.963	.927	.882
	Enlisted Availability	.960	.912	.862	.811
	Personnel Readiness*	.997	.988	.973	.953
Subsurface Ships	Officer Availability	1.000	1.000	1.000	1.000
	Enlisted Availability	.992	.960	.914	.859
	Personnel Readiness*	.999	.992	.978	.956
Aircraft Squadrons	Officer Availability	1.000	.991	.974	.943
	Enlisted Availability	.965	.916	.865	.813
	Personnel Readiness*	.997	.988	.973	.954
Shore Mission Areas	Officer Availability	.943	.888	.835	.783
	Enlisted Availability	.933	.880	.829	.781
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.997	.988	.974	.956
Total Navy	Officer Availability	.950	.900	.850	.800
	Enlisted Availability	.950	.900	.850	.800
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.997	.988	.974	.955

* Personnel readiness computed in accordance with modified utility evaluation concept described in Section IV.D

Table V-3

SUMMARY OF PERSONNEL AVAILABILITY
AND READINESS WITH NO MANNING LEVEL RESTRICTIONS
BASIC POPULATION - MAINTENANCE

Force Group	Availability/Readiness Category	Percent Shortfall			
		5	10	15	20
Surface Ships	Officer Availability	.981	.943	.897	.846
	Enlisted Availability	.957	.908	.858	.808
	Personnel Readiness*	.996	.987	.972	.952
Subsurface Ships	Officer Availability	1.000	1.000	1.000	1.000
	Enlisted Availability	.990	.952	.901	.846
	Personnel Readiness*	.999	.991	.976	.954
Aircraft Squadrons	Officer Availability	.992	.966	.925	.878
	Enlisted Availability	.963	.914	.863	.812
	Personnel Readiness*	.997	.987	.971	.951
Shore Mission Areas	Officer Availability	.936	.879	.827	.776
	Enlisted Availability	.930	.876	.826	.778
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.996	.986	.972	.953
Total Navy	Officer Availability	.950	.900	.850	.800
	Enlisted Availability	.950	.900	.850	.800
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.996	.987	.972	.953

* Personnel readiness computed in accordance with modified utility evaluation concept described in Section IV.D

Table V-4

SUMMARY OF PERSONNEL AVAILABILITY
AND READINESS WITH NO MANNING LEVEL RESTRICTIONS
BASIC POPULATION - OWN UNIT SUPPORT

Force Group	Availability/Readiness Category	Percent Shortfall			
		5	10	15	20
Surface Ships	Officer Availability	.991	.964	.931	.887
	Enlisted Availability	.980	.943	.899	.849
	Personnel Readiness*	.999	.992	.980	.961
Subsurface Ships	Officer Availability	1.000	1.000	1.000	1.000
	Enlisted Availability	1.000	1.000	.987	.952
	Personnel Readiness*	1.000	1.000	.995	.978
Aircraft Squadrons	Officer Availability	.999	.987	.960	.921
	Enlisted Availability	.996	.970	.927	.872
	Personnel Readiness*	1.000	.995	.983	.962
Shore Mission Areas	Officer Availability	.946	.893	.841	.790
	Enlisted Availability	.936	.879	.826	.776
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.997	.989	.975	.957
Total Navy	Officer Availability	.950	.900	.850	.800
	Enlisted Availability	.950	.900	.850	.800
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.997	.989	.976	.957

* Personnel readiness computed in accordance with modified utility evaluation concept described in Section IV.D

Table V-5

SUMMARY OF PERSONNEL AVAILABILITY
AND READINESS WITH NO MANNING LEVEL RESTRICTIONS
BASIC POPULATION - SUPPLY

Force Group	Availability/Readiness Category	Percent Shortfall			
		5	10	15	20
Surface Ships	Officer Availability	.997	.976	.941	.894
	Enlisted Availability	.967	.919	.869	.818
	Personnel Readiness*	.997	.987	.971	.948
Subsurface Ships	Officer Availability	1.000	1.000	.994	.923
	Enlisted Availability	1.000	.994	.960	.897
	Personnel Readiness*	1.000	.999	.989	.961
Aircraft Squadrons	Officer Availability	1.000	1.000	.996	.938
	Enlisted Availability	.983	.938	.888	.836
	Personnel Readiness*	.998	.989	.973	.952
Shore Mission Areas	Officer Availability	.931	.868	.811	.761
	Enlisted Availability	.925	.869	.818	.770
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.996	.987	.972	.953
Total Navy	Officer Availability	.950	.900	.850	.800
	Enlisted Availability	.950	.900	.850	.800
	Civilian Availability	.950	.900	.850	.800
	Personnel Readiness*	.996	.987	.972	.953

* Personnel Readiness computed in accordance with modified utility evaluation concept described in Section IV.D

addressed subsequently in the approach critique presented in the next section of this chapter. For the most part, the personnel readiness values do not significantly differ across the four force groups for a given shortfall level. This reflects the intent of the modified utility approach where shortfalls in individual categories are applied to activities where the least degradation in utility would be achieved, so that personnel readiness tends to remain on even levels especially when applied to large sub-groups of activities such as the force groups considered in this analysis.

The personnel availability values obtained show that the Subsurface Ship Force Group, with the smallest average activity personnel complements among the four force groups, exhibits the highest officer and enlisted availabilities, while the Shore Mission Area Force Group, with the highest average activity personnel complements, exhibits the lowest officer and enlisted availabilities. This is as would be expected since the modified utility approach applies the shortfalls proportionately more heavily on the larger activities than the smaller ones. The ranges in officer and enlisted availabilities portrayed in the total results presented in the five summary tables are as given in the following table.

Shortfall Percentage	Officer Availability		Enlisted Availability	
	Minimum	Maximum	Maximum	Minimum
5	.931	1.000	.925	1.000
10	.868	1.000	.869	1.000
15	.811	1.000	.818	.987
20	.761	1.000	.770	.952

The civilian availabilities obtained are the direct unity complement of the shortfalls, as the Shore Mission Area Force Group is the only force group of the subgroups that contain civilian personnel. It should be noted here that this holds for all three personnel categories for the Total Navy Force Group, since these availabilities reflect the total impact of the shortfalls.

The summary results presented in Table V-6 show the variations in force group average personnel availabilities and readiness for an assumed 20% shortfall under the three different minimum manning level requirements. These results indicate the general trend of shifting shortfalls from the afloat force groups with the higher minimum manning level requirements (80% or 90%) to the ashore force group with the lower minimum manning level requirement (70%). For the 80% requirement imposed on the afloat forces, some shifting of the shortfalls from the Surface Ship Force Group to the Subsurface Ship and Aircraft Squadron Force Groups, in addition to the ashore force group, also takes place. However, at the 90% minimum manning level requirement, the shifting is totally from the afloat force groups to the ashore force group. Under the 90% minimum manning level requirement on the afloat forces, the enlisted availabilities do not meet this requirement for each of the three force groups even though the enlisted availability for the ashore force group is above its 70% requirement. This implies that there are insufficient enlisted personnel in specific utility skill group/pay grade categories ashore to absorb the increased shortfalls imposed because of the higher afloat manning level requirements.

The summary results presented in Table V-7 show the variations in force group minimum (as opposed to average) personnel availabilities and readiness for the same cases used in Table V-6. These minimum values are the minimum of the individual activity values within each force group. These results generally mirror those presented in Table V-6, although the values are obviously lower in magnitude.

B. Critique of Proposed Approach

The modified utility evaluation concept, as described in Section IV.D, represents an initial approach toward evaluating the effects of personnel shortfalls on Navy personnel readiness relative to logistics support functions. This approach is based on defining personnel readiness as the ratio of the sum of the

Table V-6

SUMMARY OF AVERAGE PERSONNEL AVAILABILITY
AND READINESS WITH 20% SHORTFALLS
BASIC POPULATION - DESIGNATED LOGISTICS

Force Group	Availability/Readiness Category	% Manning Level Restrictions					
		AFL 0	ASH 0	AFL 80	ASH 70	AFL 90	ASH 70
Surface Ships	Officer Availability	.882		.885		.919	
	Enlisted Availability	.811		.815		.826	
	Personnel Readiness*	.953		.955		.959	
Subsurface Ships	Officer Availability	1.000		1.000		1.000	
	Enlisted Availability	.859		.854		.859	
	Personnel Readiness*	.956		.955		.957	
Aircraft Squadrons	Officer Availability	.943		.940		.950	
	Enlisted Availability	.813		.814		.825	
	Personnel Readiness*	.954		.953		.958	
Shore Mission Areas	Officer Availability	.783		.783		.778	
	Enlisted Availability	.781		.778		.765	
	Civilian Availability	.800		.800		.800	
	Personnel Readiness*	.956		.956		.954	
Total Navy	Officer Availability	.800		.800		.800	
	Enlisted Availability	.800		.800		.800	
	Civilian Availability	.800		.800		.800	
	Personnel Readiness*	.955		.955		.955	

AFL - Afloat Forces

ASH - Ashore Forces

* Personnel readiness computed in accordance with modified utility evaluation concept described in Section IV.D

Table V-7

SUMMARY OF MINIMUM PERSONNEL AVAILABILITY
AND READINESS WITH 20% SHORTFALLS
BASIC POPULATION - DESIGNATED LOGISTICS

Force Group	Availability/Readiness Category	% Manning Level Restrictions					
		AFL 0	ASH 0	AFL 80	ASH 70	AFL 90	ASH 70
Surface Ships	Officer Availability	.810		.821		.847	
	Enlisted Availability	.787		.801		.809	
	Personnel Readiness*	.948		.950		.954	
Subsurface Ships	Officer Availability	1.000		1.000		1.000	
	Enlisted Availability	.848		.844		.851	
	Personnel Readiness*	.955		.954		.956	
Aircraft Squadrons	Officer Availability	.786		.800		.786	
	Enlisted Availability	.792		.801		.809	
	Personnel Readiness	.950		.950		.955	
Shore Mission Areas	Officer Availability	.775		.775		.769	
	Enlisted Availability	.765		.760		.750	
	Civilian Availability	.799		.799		.799	
	Personnel Readiness*	.949		.948		.940	

AFL - Afloat Forces

ASH - Ashore Forces

* Personnel readiness computed in accordance with modified utility evaluation concept described in Section IV.D

utilities of personnel assigned to a given activity (group of activities) to the sum of the utilities of personnel authorized to the given activity (group of activities). Initially, personnel within a given utility skill group/pay grade combination are assigned a constant utility value, regardless of the activity to which assigned. These utility values are then modified to reflect the relative utility of a person in relation to the authorized strength of an activity for each skill group/pay grade combination. That is, the utility value associated with the x^{th} person in a particular skill group/pay grade combination assigned to a given activity depends on the number of personnel of that skill group/pay grade combination authorized to that activity and this utility value varies inversely (in a linear manner) with the value of x . Thus, the utility loss associated with losing one person when an activity is at its authorized strength with respect to a skill group/pay grade combination is much less than the utility loss associated with losing one person when the activity is at, say, one-half its authorized strength for that skill group/pay grade combination. Also, if one activity is assigned, say, twice as many personnel of a particular skill group/pay grade combination than is another activity, then the utility loss associated with the loss of one person from the first activity will be much less than the utility loss associated with the loss of one person from the second activity.

This type of approach has two significant features useful for evaluating personnel readiness in the presence of personnel shortfalls. The first useful feature is the relating of personnel readiness to the utility associated with assigned personnel to an activity. This provides a logical basis for assessing personnel readiness in terms of the relative worth of specific personnel billets to the performance of an activity's mission requirements. Although each billet authorized to an activity is necessary to the full performance of the activity's prescribed missions, these billets have differing criticalities with regard to mission performance. For example, a yeoman is certainly necessary for the

efficient conduct of administrative duties aboard a ship at sea. However, the loss of such a person would have much less of an effect on the ship's mission performance than the loss of a person, such as a fire control technician, possessing a high level of mission-essential skills, especially under combat conditions.

The second useful feature of the proposed approach is in the capability of optimizing personnel readiness over a group of activities in the presence of personnel shortfalls within specific skill group/pay grade combinations. That is, this approach provides a rational method for distributing personnel shortfalls among a group of activities so as to minimize the degradation of the overall personnel readiness of that group of activities. For example, if Ship A is authorized only two electronic technicians within a specific pay grade and Ship B is authorized ten such technicians, then the procedure would prescribe vacating an electronic technician billet aboard Ship B before vacating such a billet aboard Ship A if a shortfall of electronic technicians of that pay grade existed.

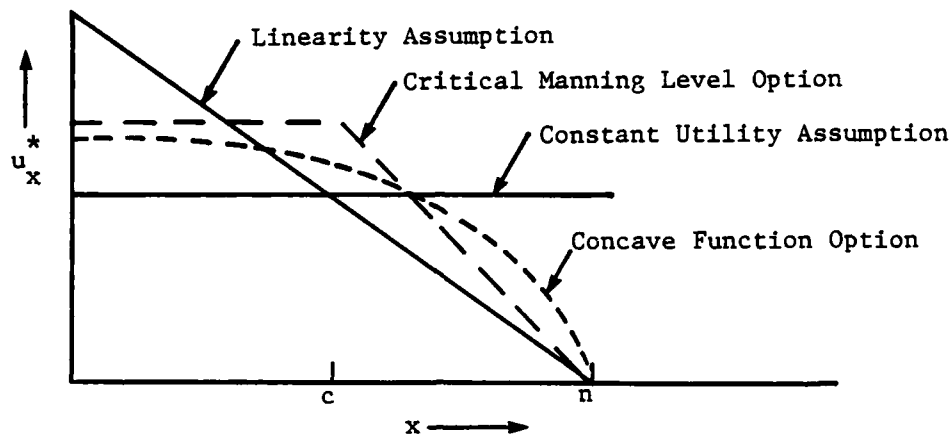
One desirable feature that is not included in the proposed approach is the capability for personnel substitution either among pay grades within a specific skill category or among skill categories for a specific pay grade. That is, if a specific activity is short an electronic technician of Grade E-6, there is no provision for filling that vacancy with an electronic technician of a different pay grade or with a person of Grade E-6 with a different rating.

The discussion thus far has addressed the underlying concepts of the proposed approach. The actual implementation of this approach, as described in Chapter IV, represents an initial attempt to apply these concepts to evaluating Navy personnel readiness in the presence of assumed personnel shortfalls. This implementation consists of two major components: data base consolidation and optimization computer program design. The data base consolidation embodies the transformation of the basic personnel data bases to utility structured data bases. This data base consolidation resulted in a considerable reduction in the

number of data base factors. That is, officer designators, EP ratings, and civilian occupational code groups were each assigned to one of seven utility skill groups (252 separate categories reduced to seven utility skill groups) and the various officer, enlisted, and civilian pay grades were assigned to one of 18 utility pay grades (88 separate pay grades reduced to 18 utility pay grades). The principle advantage of this consolidation is the reduction in the maximum possible number of allocation optimizations from 22,176 to 504 for a given computer run. This results in a substantial reduction in required computer running time. A disadvantage of this consolidation is the loss of identity of actual billets. That is, the distribution of shortfalls among officers, enlisted personnel or civilians are specified in terms of utility skill groups and utility pay grades. The utility skill group results cannot reasonably be transformed back to specific officer designators, EP ratings, or civilian occupational code groups. However, the utility pay grade results can, for the most part, be transformed back to officer, enlisted and civilian pay grades. This could be offset somewhat by increasing the number of utility skill groups so that each skill group would contain fewer officer designators, EP ratings, and civilian occupational codes and the skill group definitions themselves could be revised to be more related to specific Naval functions. For example, the definitions could coincide with the definitions of the Shore Mission Areas. This revision of definitions would also result in a more efficient basis for assigning officer designators, EP ratings, and civilian occupational codes to specific utility skill groups. Of course, this would require the establishment of a new and improved set of utility values for the skill groups. Even if the original seven skill groups were maintained, an improved set of utility values should be established since the values used in this analysis were somewhat arbitrarily generated. Another area where improvement is required is in the componentization of shore based activities

where the nature of these activities should be more compatible with that of the afloat activities (ships and aircraft squadrons) than are the Shore Mission Areas. One such option would be to use the actual shore activities such as Alameda Naval Air Station, Oakland Naval Supply Center, Washington Naval Shipyard and so on. This revision, as well as the skill group redefinition, would obviously increase the number of data base factors and thus increase computer running time requirements. On the other hand, it should also add credibility to the results obtained through the use of the approach.

The Utility Optimization Computer Program (UALLOC), described in Section IV.E represents a convenient and efficient tool for evaluating personnel readiness in the presence of personnel shortfalls. The principal drawback of the program is that it generates abnormally high values for personnel readiness in relationship to the personnel availabilities obtained, as can be seen through perusal of the tables presented in the preceding section of this chapter. For example, in Table V-1 which provides the results for shortfalls across the entire Navy population, the Shore Mission Area results for a 20% shortfall indicate personnel availabilities of .779 for officers, .785 for enlisted personnel, and .800 for civilians, while the personnel readiness value obtained is .955. The high readiness values generated by the program imply that the linearly variant utility assumption, used to establish the relative utility values of personnel authorized to an activity within a specific utility skill group/pay grade combination, places too little utility value at the end of the personnel scale. One possible option to correct this problem would be to establish a critical manning level, say 80%, where relative utility would be constant up to this critical level and then decrease linearly up to the 100% level. Another option would be to use a concave function instead of a linear function to represent relative utility. The figure below illustrates the functions associated with these two options as well as the functions associated with the original linearity assumption and a



constant utility assumption. In the figure, x denotes the x^{th} person out of n authorized to an activity and u_x denotes the relative utility associated with the x^{th} person. Implementation of either of the two options would require a major revision of the optimization subroutine of the computer program with only minor revisions to the main program. Another drawback of the program is the assumption that shortfalls are uniform over utility skill groups and pay grades. That is, if a shortfall of, say, 80% is assumed, then each utility skill group/pay grade combination is assumed to have an 80% shortfall. One possible remedy to this problem would be to allow non-uniform shortfall distributions over the utility skill groups and pay grades. This would allow evaluation of personnel readiness in such cases where there is a higher shortfall among, say, personnel in the highly critical skill areas or with higher pay grades than among those in less critical skill areas or with lower pay grades. Implementation of the above two proposed improvements would result in a more useful and credible computer program as a tool for evaluating personnel readiness in the presence of personnel shortfalls.

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